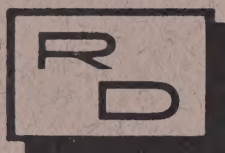


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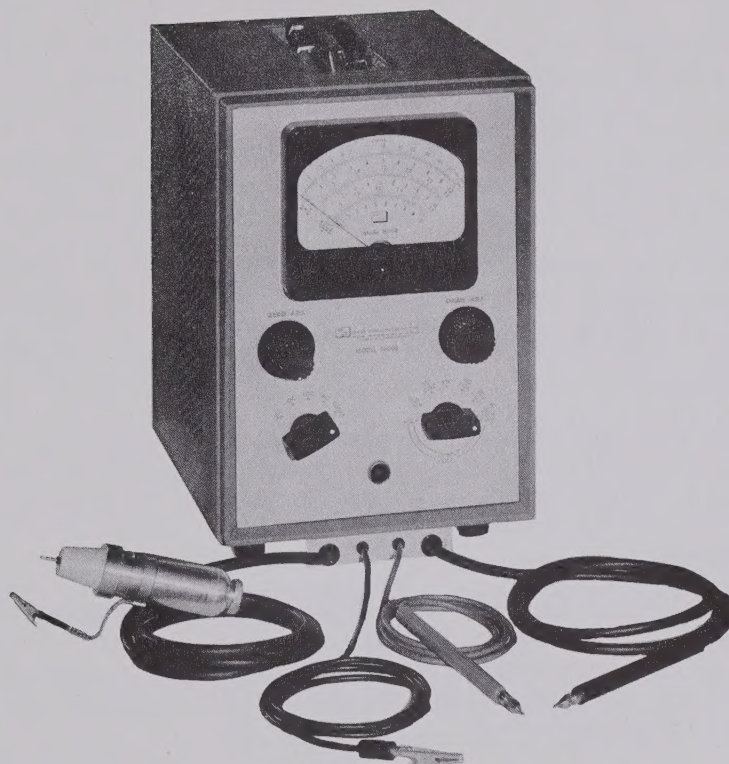
INSTRUCTION MANUAL

for

**HIGH FREQUENCY
VACUUM TUBE VOLTMETER
MODEL 1600B**

THE HICKOK ELECTRICAL INSTRUMENT COMPANY • 10514 Dupont Avenue, Cleveland 8, Ohio





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HIGH FREQUENCY VACUUM TUBE VOLTMETER MODEL 1600B

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PHONE — 541-8060
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WARNING

This instrument is capable of being used to measure voltages dangerous or deadly to the operator. Use extreme care when measuring high voltages to prevent contact with either the circuit under test or the probe tip used to make the measurement.

The common test lead is connected to the VTVM chassis and case. Use of the instrument to measure OFF - GROUND voltages is discouraged as the instrument case and ground circuits may be at a dangerous potential with respect to actual ground.

Also, should the grounding conductor of the power cable be grounded, the instrument cannot be used to measure voltages with the common side at a potential with respect to power line ground, since this voltage will be shorted out and damage to the circuit may result.

STANDARD EIA GUARANTEE

The Hickok Electrical Instrument Company warrants instruments manufactured by it to be free from defective material or factory workmanship and agrees to repair such instruments which, under normal use and service, disclose the defect to be the fault of our manufacturing. Our obligation under this warranty is limited to repairing any instrument or test equipment which proves to be defective, when returned to us transportation prepaid, within 90 days from the date of original purchase, and provided the serial number has been made known to us promptly for our records.

This warranty does not apply to any of our products which have been repaired or altered by unauthorized persons or service stations in any way so as, in our judgment, to injure their stability or reliability, or which have been subject to misuse, negligence, or accident, or which have had the serial number altered, effaced or removed. Neither does this warranty apply to any of our products which have been connected, installed, or adjusted otherwise than in accordance with the instructions furnished by us. Accessories, including all vacuum tubes not of our manufacture, used with this product are not covered by this warranty.

This warranty is in lieu of all other warranties expressed or implied, and no representative or person is authorized to assume for us any other liability in connection with the sale of our products.

Parts will be made available for a minimum period of five years after the manufacture of this equipment has been discontinued. Parts include all materials, charts, instructions, diagrams, accessories, etc., which have been furnished in the standard model.

RETURNING EQUIPMENT FOR REPAIR

Before returning any equipment for service, under warranty or otherwise, the factory must first be contacted giving the nature of the trouble. Instructions will then be given for either correcting the trouble or returning the equipment. Upon authorization, this equipment should be forwarded directly to the Hickok factory address, 10636 Leuer Avenue, Cleveland, Ohio, or to a designated service station in your locality. All correspondence pertaining to repairs should be directed to the Hickok office address, 10514 Dupont Avenue, Cleveland 8, Ohio, or to the authorized service station designated.

REGISTRATION CARD

The above guarantee is contingent upon the attached registration card being returned to the factory immediately upon receipt of the equipment.

THE HICKOK ELECTRICAL INSTRUMENT COMPANY
Cleveland, Ohio

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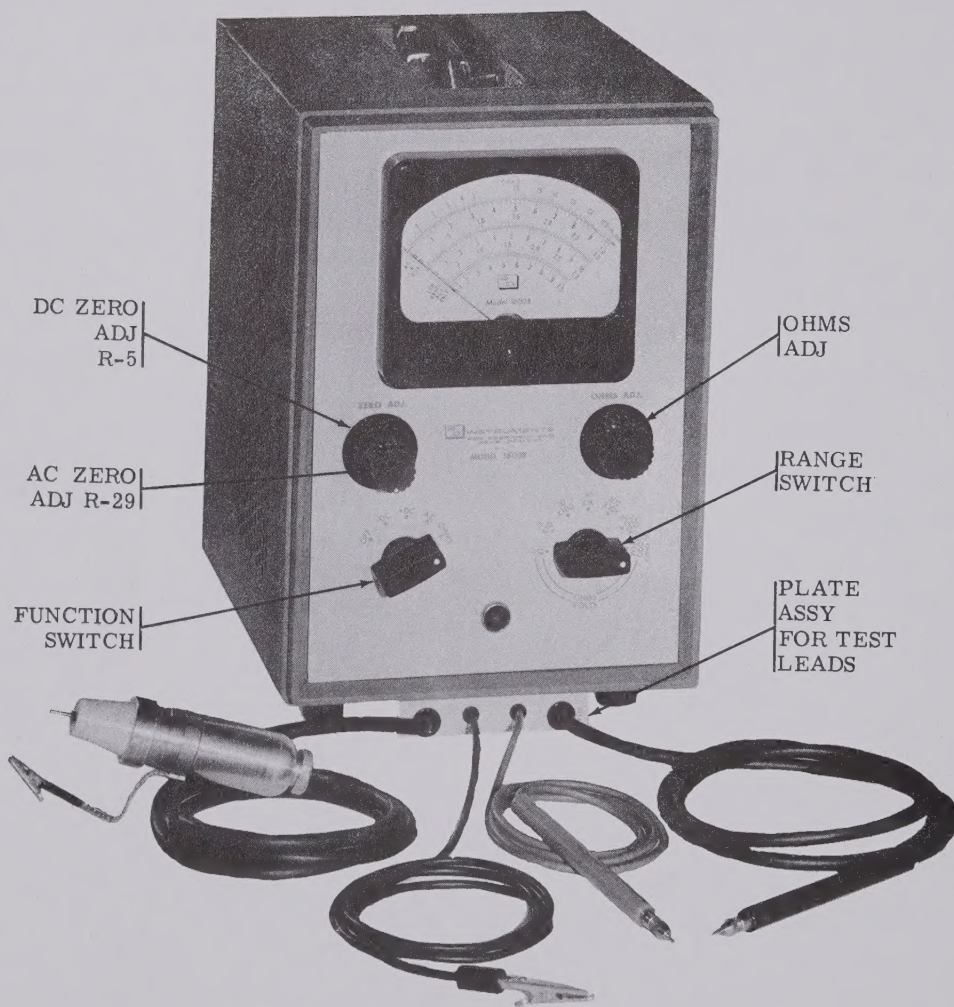


Figure 1-1. Model 1600B - Vacuum Tube Voltmeter

SECTION I

INTRODUCTION AND DESCRIPTION

1-1. INTRODUCTION

1-2. This Technical Manual provides operation and service instructions for the Vacuum Tube Voltmeter, Model 1600B, which is manufactured by The Hickok Electrical Instrument Company of Cleveland, Ohio. The Hickok part number is 902-407.

1-3. This publication includes all information necessary to set up, operate and maintain the Voltmeter. Maintenance instructions are limited to those procedures that can be performed with tools normally available to technicians required to use the equipment. It does not include complete overhaul instructions and realignment procedures.

1-4. DESCRIPTION. See Figure 1-1.

1-5. PURPOSE. The Model 1600B Vacuum Tube Voltmeter (see identifying view on page 0-1) is an accurate stable test instrument. The meter has provisions for measuring resistance in ohms as well as DC and AC voltages. The circuitry of the meter is such that it presents an extremely high impedance to the voltage under test. It reduces to a minimum the loading effect of the meter on the circuit to which it is connected and extends the use of the meter to almost any type of electronic or electrical equipment.

1-6. CAPACITIES AND LIMITATIONS. The ranges of the Voltmeter together with other leading particulars are given in tabular form in figure 1-2.

1-7. CONSTRUCTION. The Voltmeter is a portable self-contained unit housed in an aluminum case. The chassis and front panel are removable for maintenance. The four test leads, identified in paragraphs a through d below, are attached to the underside of the meter.

a. COMMON: Black unshielded with alligator clip.

b. AC TEST LEAD: Black shielded with AC probe attached.

c. DC TEST LEAD: Black shielded cable with black probe.

d. OHMS TEST LEAD: Red unshielded with RED probe.

e. The basic measuring circuit is a direct current balanced amplifier. The input to the measuring circuit is applied through a precision voltage divider when measuring AC or DC voltages. AC voltages are rectified by the diode rectifier in the AC probe before being applied to the voltage divider.

f. A separate voltage divider is used when measuring resistance. The voltages necessary for measuring resistance are derived from the internal power supply, thus eliminating periodic testing and replacement of batteries.

CHARACTERISTIC	VALUE
Input Voltage.	115 or 230 Volts, $\pm 10\%$ 50 to 1000 CPS AC
Ranges	
Volts AC	.0-1/3/10/30/100/300
Volts DC	.0-1/3/10/30/100/300/1000
Ohms	X1, 10, 100, 1K, 10K, 100K, 1 MEG.
Center Scale Readings	10, 100, 1000, 10K, 100K, 1 MEG., 10 MEG.
Frequency Response	$\pm 1\text{DB}$, 10 CPS to 700MCS
Input Impedance	
Volts AC (at low frequencies).	10 Megohms shunted by 1 UUF
Volts DC	122 Megohms
Meter	
Type	Hickok, Model 68
Sensitivity	.100UA
Accuracy	
+DC Volts	$\pm 3\%$ of full scale
-DC Volts	$\pm 3\%$ of full scale
AC Volts.	$\pm 3\%$ of full scale
Ohms	± 1 ohm, X1 Range, $\pm 5\%$ all other ranges
Physical Dimensions	
Height	11-5/8 inches
Width	7-11/16 inches
Depth	10 inches

Figure 1-2. Table of Leading Particulars

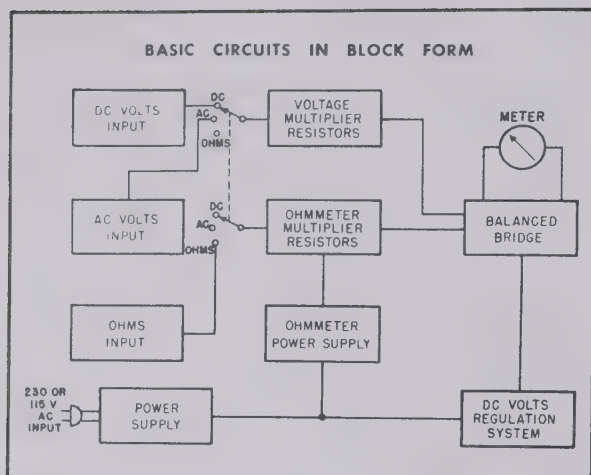


Figure 1-3. Block Diagram of Voltmeter Circuits

1-8. SIMPLIFIED PRINCIPLES OF OPERATION

1-9. The following discussion is presented so that the user of this instrument may better understand its operation; and therefore be able to realize its full capabilities. An understanding of the principles of operation will also help the user during service and repair procedures. Refer to figures 1-3 and 3-2.

1-10. BRIDGE CIRCUIT (see figure 3-2). The input selected by the Function switch is supplied to a balanced bridge circuit that is common to all operations. The bridge circuit consists of two 6AU6 pentodes in a balanced DC circuit. The meter is connected between the cathodes of the two pentodes and indicates the degree to which the circuit is balanced or unbalanced. The bridge is properly balanced when the meter indicates zero with no voltage applied to the grid of V2.

a. Balance of the bridge is accomplished by varying the screen potential with the DC ZERO ADJUST control R5, (figures 1-1 and 3-2) until the currents through the cathodes are equal (with no voltage applied to the grid of V2).

b. Operating bias of the bridge is adjusted by the internal 50K ohm BIAS control R27 (Figure 1-4). Proper bias is obtained when the grid currents in the 6AU6 tubes are at a minimum, as indicated by the absence of shift of the meter pointer from the zero position when the Range switch is switched through its DC voltage positions. Momentary surges should be disregarded.

c. A high degree of degeneration is incorporated into the design of the bridge, thus reducing the unbalancing effect of tube replacement.

1-11. DC VOLTMETER (see figure 3-2). The isolating resistor R2 contained in the DC probe serves to isolate the shunt capacitance of the shielded test lead from the circuit under test. R2 in series with R7, R10, R15, R17, R21, R23 and R28, forms a voltage attenuator.

a. The degree of attenuation is determined by the position of the Range switch. The attenuation is such that the voltage applied to the bridge circuit is the same for full scale deflection on each range. Calibration of the entire DC measuring circuit is accomplished by the internal calibration potentiometer DC CAL R26 (Figures 1-4 and 3-2).

b. Either plus or minus DC voltages may be measured by setting the Function switch to the desired polarity. The high impedance of the voltage attenuator (122 megohms) was selected to minimize the loading effect on the circuit under test.

1-12. AC VOLTMETER (See figures 3-1 and 3-2). Diode V1, located in the AC probe, together with charging capacitor C1, acts as a peak detector. The DC output of the detector is filtered by capacitor C2 before being applied to the voltage attenuator network. The attenuated voltage is applied to the bridge and measured in the same manner as the DC voltage.

a. The slight negative contact potential developed by diode V1 is cancelled by application of a small positive voltage at the junction of R1 and S2. The positive potential is applied through R38 and is adjusted to a suitable value by means of the AC ZERO ADJ control on the front panel.

b. Each range of the AC Voltmeter is individually calibrated by a separate potentiometer. These potentiometers assure accurate calibration in all AC ranges. The reference designation of the calibration potentiometers and their corresponding meter ranges are as follows; 1v range-R4, 3v range-R6, 10v range-R9, 30v range-R14, 100v range-R43, and the 300v range-R44, (See Figure 1-4).

1-13. OHMMETER (see figure 3-2). The ohmmeter circuit consists of a group of precision resistors connected in series with the DC voltage supply. The ohms probe is connected directly to the bridge circuit.

a. When the ohmmeter test leads are shorted together the voltage applied to the bridge input circuit is zero. When the ohms probe is disconnected from ground, the full voltage of the ohmmeter power supply is applied to the bridge input. Under this condition the sensitivity of the bridge circuit is varied by the OHMS ADJ control until the DC voltage which is applied to the bridge is sufficient to cause the meter to indicate full scale or "infinity" ohms.

b. When an unknown resistor is connected between the ohms probe and ground lead, it is placed in series with one or more of the precision resistors. The resulting voltage drop across the known precision resistance is a positive indication of the value of the unknown resistor. This voltage drop is applied to the grid of the bridge circuit. The resultant meter deflection is indicated in terms of ohms.

1-14. POWER SUPPLY. Design of the power supply is such that it insures stable regulated voltages despite variations in load demands or in supply voltage fluctuations.

a. The power transformer of the 1600B has a dual primary which can be connected in parallel for 115 volt operation or in series for 230 volt operation. 115 or 230 volt operation is selected by setting switch S-3 (Figures 1-5, 3-2) for the proper operation voltage. Regulation of the entire B supply is accomplished by a shunt type pentode regulator tube V5.

b. The negative B supply lead is clamped at a definite level with respect to the chassis ground by a gaseous regulator tube VR2. The regulated positive B supply is referenced to B minus through the voltage divider R35, R37, R40, and the gaseous regulator tube VR1. Any tendency of the total regulated B supply voltage to change due to changes in either the load cur-

rent or supply voltage will cause a change in the voltage drop across the voltage divider. Such changes are applied to the control grid of the pentode regulator tube V5 in such a relationship as to cause the regulator to correct for the change in voltage.

c. The EA-52 AC diode V1, and the 6AU6 Bridge Tubes V2 and V3 filaments are supplied with regulated voltage. A 12.6V supply from the power transformer is fed to a 9-4 ballast regulator tube V6, and the constant voltage output supplies the filaments of V1, V2 and V3.

The 6X4 rectifier tube V4 and 6AU6 shunt regulator V5 are supplied unregulated 6.3 V AC for the filaments.

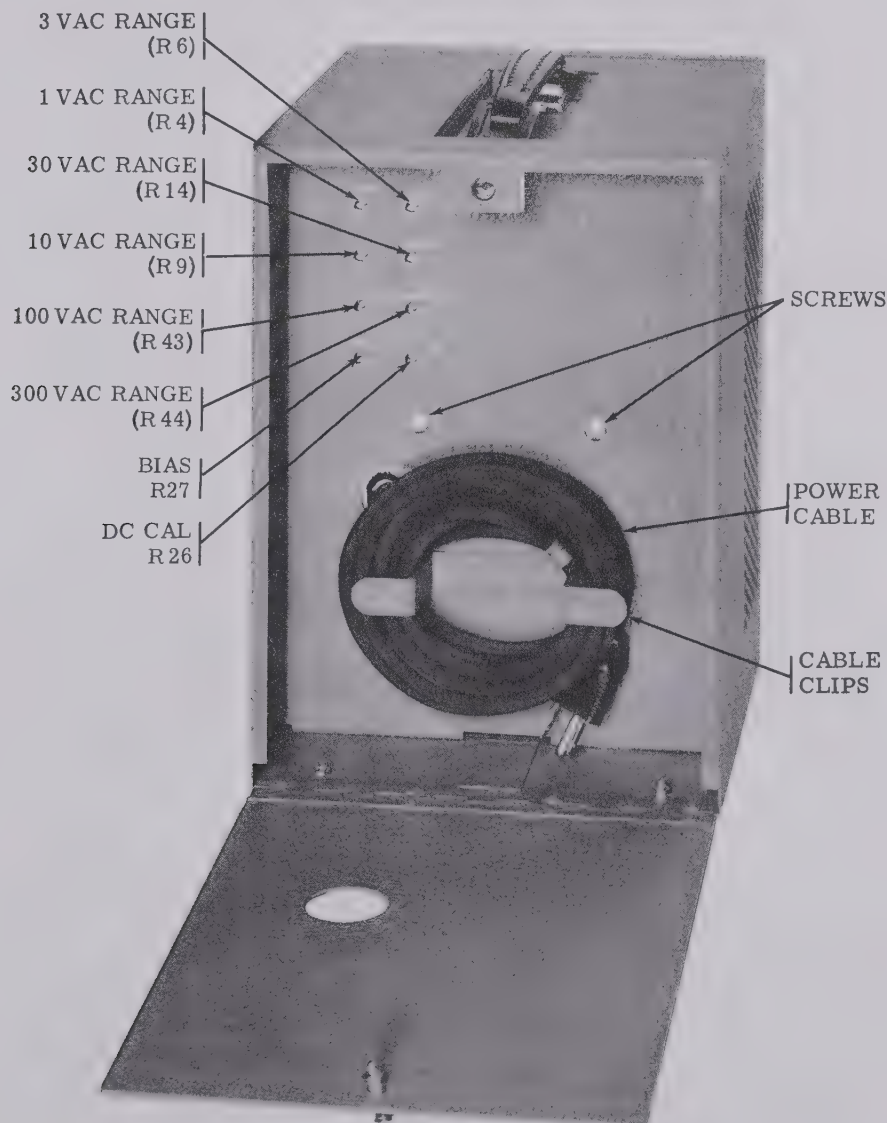


Figure 1-4. Rear Panel Open - Showing Adjustments

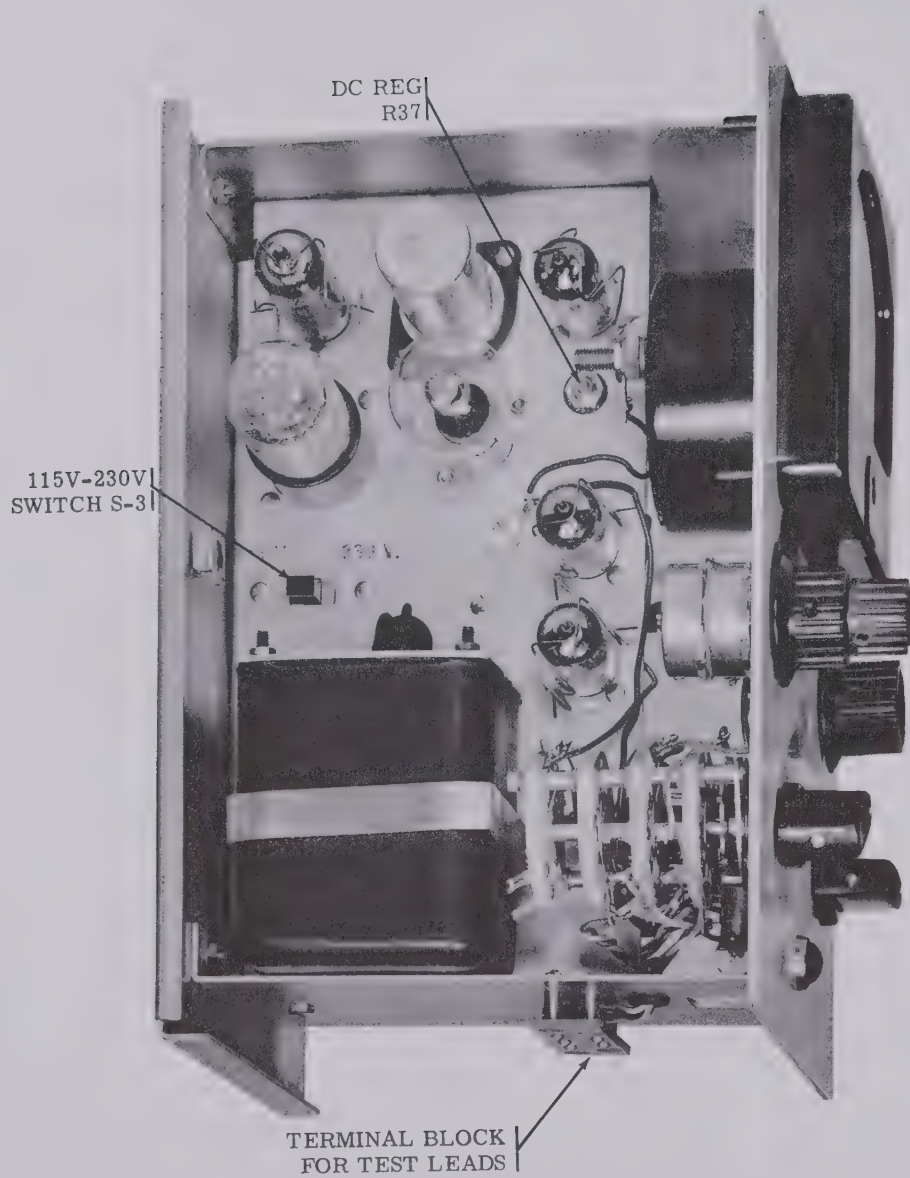


Figure 1-5. Left Side of Chassis

SECTION III

PERIODIC INSPECTION, MAINTENANCE AND LUBRICATION

3-1. INSPECTION

3-2. Periodically perform a preventive maintenance inspection. Check all parts which can be examined without removing the voltmeter from its case. Inspect for general cleanliness and overall appearance. Check controls for positive yet smooth action. Check insulation of probes and the power cable for frayed spots and other insulation damage. Examine instrument carefully for any condition which could possibly cause it to fail.

3-3. PREVENTIVE MAINTENANCE

3-4. Routine replacement of tubes and obviously damaged components constitutes the extent of field maintenance requirements. Potentiometer adjustments may be necessary to recalibrate the instrument (refer to Section V).

3-5. TUBES. In the event of tube failure, tubes used for replacement should be aged in position for at least 24 hours before final calibration. To gain access to the interior of the multimeter for tube replacement purposes, proceed as follows:

a. Disconnect plate assembly at bottom of case and remove two screws at rear of case (Figure 1-4). The panel and chassis may now be completely removed

from the case for inspection and maintenance.

b. Slide chassis out of case.

3-6. To replace electron tube (12, figure 3-1) in the AC probe, proceed as follows:

a. Loosen bushing (6) at rear of AC probe and slide bushing and rubber washers (8) back about eight to ten inches along the cable (7).

b. Unscrew front housing (11) from the rear housing (5) and separate the two assemblies.

c. Take off outer ring (3) and remove the cup (1) containing the test prod (14).

d. Unsolder the 36 megohm resistor (10) from the spring clip (13) on the anode lead of electron tube (12). Carefully remove the spring clip.

e. Unsolder tube heater leads (4) from the terminal posts on the phenolic sleeve (9).

f. Unscrew inner ring (2) and remove spring (15). The electron tube (12) and washer (16) may now be removed.

g. To reassemble the AC probe, reverse the procedure described in steps a through f.

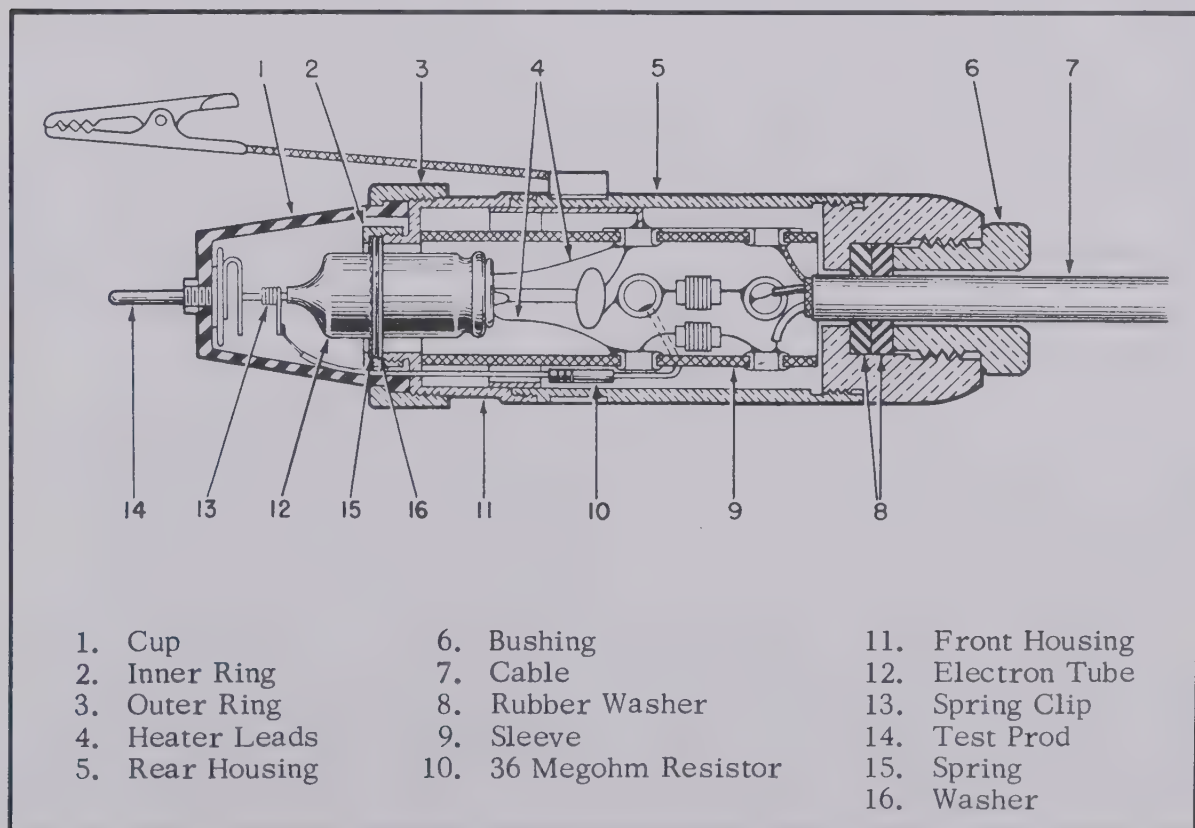


Figure 3-1. Cutaway View of AC Probe

3-7. CLEANING. Periodically wipe the multimeter with a lint-free cloth to keep it clean and free of dust. Whenever the chassis is removed, inspect the internal components for cleanliness. Remove loose dirt with a vacuum cleaner or with low pressure compressed air (approximately 30 PSI). If a surface film forms, remove it with a cloth dampened with an approved solvent, such as trichlorethylene (MIL-T-7003).

CAUTION

Exercise care while cleaning to avoid disturbing setting of the potentiometers and other alignment devices.

3-8. SCHEMATIC DIAGRAM. Figure 3-2 (in back of this Manual) is included to aid in maintenance and trouble shooting procedures. Replacement parts should be ordered by part number. To find the part number, refer to the Parts List, Section VI.

3-9. LUBRICATION

3-10. No lubrication is required.

SECTION II

OPERATING INSTRUCTIONS

2-1. FRONT PANEL CONTROLS

2-2. The operator should understand the function of each front panel control and be thoroughly familiar with them and with the meter scales before making any circuit tests. Ignorance of the placement or function of the controls could lead to serious damage to the instrument. Refer to figure 2-1 which lists each front panel control and describes its function.

CONTROL	FUNCTION
DC ZERO ADJ Control (Black Knob)	Used to set pointer on zero for DC voltage measurements (paragraph 2-6).
AC ZERO ADJ Control (Red Knob)	Used to set pointer on zero for AC voltage measurements (paragraph 2-8).
OHMS ADJ Control	Used to set pointer on infinity for resistance measurements (paragraph 2-11).
Function Switch	Turns power on; selects type of measurements to be made.
Range Switch	Selects AC or DC voltage range and indicates multiplication factor for resistance measurements.
Zero Adjust Screw (on Meter)	Provides mechanical adjustment of pointer for zero indication.

Figure 2-1. Table of Front Panel Controls

2-3. **METER SCALES.** The face of the meter bears six scales. The scales are read directly, or the reading is multiplied by various factors, depending upon the position of the Range switch. The various voltage and resistance ranges are listed in figure 1-2. With continued practice the correct scale can be read easily as the Range switch is moved to the desired position.

2-4. TURNING ON VOLTMETER

2-5. The voltmeter is designed for use with either a 115 volt or 230 volt AC power source. The instrument is shipped for use with a 115 volt supply. Before placing the instrument into operation determine the power source available and ascertain that the voltage change switch (inside chassis - Figure 1-5) is in the proper operating position. Access to the voltage change switch is made possible by removing the four screws from the plate assembly for test leads (Figure 1-1), two screws from the rear of the case (Figure 1-4) and pulling the chassis out of the case. After establishing that the voltage change switch is in proper position (115 or 230V) restore the unit to operating condition. Connect to power source. Turn the Function switch from OFF to any other position. (Pilot light should glow) Allow the instrument to warm up for at least five minutes before making circuit tests.

NOTE

Typical methods of connecting the Voltmeter to the equipment under test are shown in fig. 2-2.

2-6. MAKING DC VOLTAGE MEASUREMENTS

2-7. DC voltage measurements are made by using the common test lead (black with alligator clip) and the DC test lead (black with black probe).

a. Set Function switch to - DC or + DC, depending upon the polarity of the DC voltage being measured. Polarity may be reversed, if necessary, by resetting this switch.

b. Set Range switch on the 1V position. Connect the common test lead to the DC test lead and adjust the DC ZERO ADJ control for a zero reading on the meter using the black concentric knob.

NOTE

It should not be necessary to reset the DC ZERO ADJ control when using other voltage ranges.

c. Now, set Range switch to the correct range for voltage being measured.

NOTE

If the magnitude of the voltage is unknown set the Range switch to the 1000V DC position. If the meter pointer fails to deflect or deflects only slightly when test leads are connected, reset the Range switch until the proper range is found.

d. Connect alligator clip on common lead to the common, or ground, terminal. Touch probe to test point (see figure 2-2, detail A) and read meter. If the meter deflects down scale to the left, reset the Function switch to reverse polarity.

WARNING

When making high voltage measurements (DC or AC) keep hands away from tip of probe.

2-8. MAKING AC VOLTAGE MEASUREMENTS

2-9. **GENERAL.** The AC probe and common test lead are used for AC measurements below frequencies of several megacycles. For high frequency measurements up to 200 megacycles, the short ground lead attached to the AC probe is substituted for the common lead.

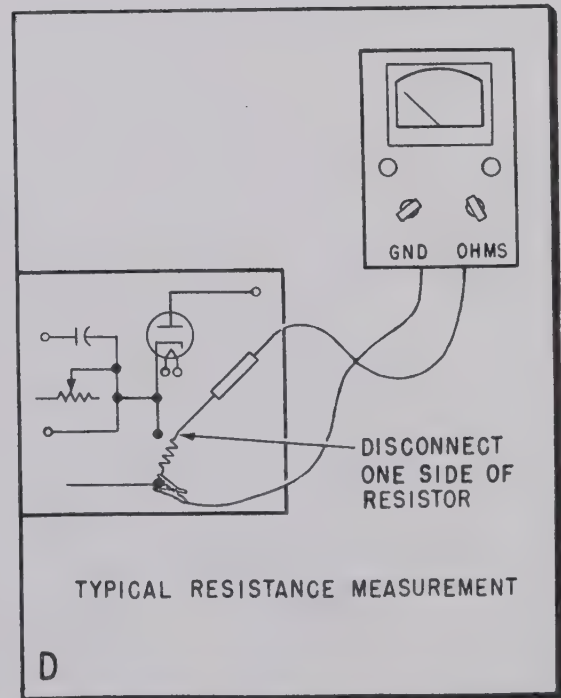
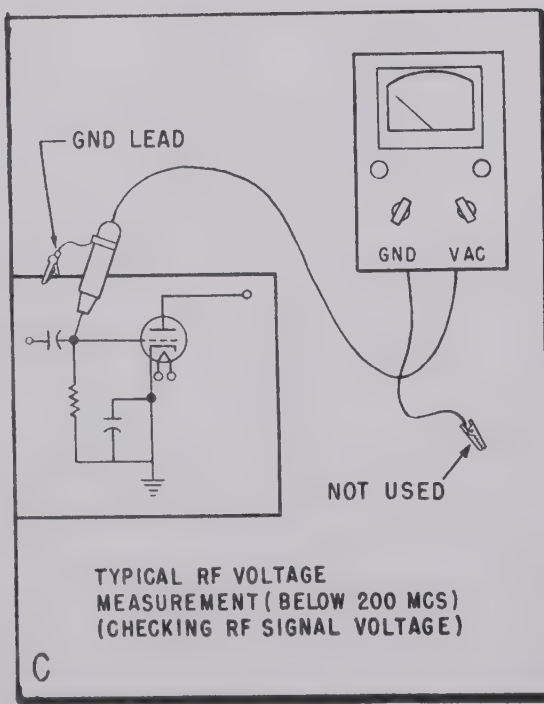
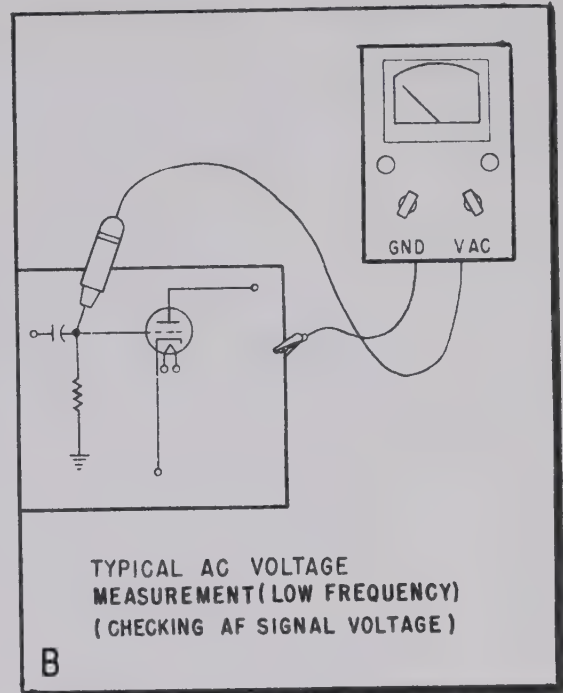
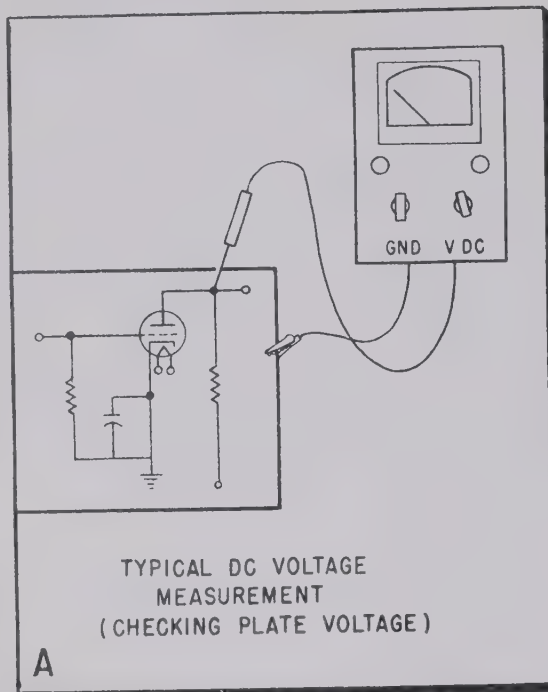


Figure 2-2. Methods of Connecting Multimeter for Voltage and Resistance Measurements

2-10. To make AC Voltage measurement, proceed as follows:

a. After setting DC ZERO ADJ (paragraph 2-7b) set Function switch to AC and the Range switch to the 1V position. Adjust the meter pointer for zero reading by using the AC ZERO ADJ control.

NOTE

The AC ZERO ADJ control should not have to be readjusted as the Range switch is moved

b. Set the Range switch to the correct position for the voltage to be measured. If the approximate voltage is not known, start with the 300V position and then shift to the lower ranges as required.

c. For frequencies below several MCS, connect alligator clip on common lead to the common or ground terminal.

d. For frequencies up to 200 MCS, connect alligator clip on AC probe to ground.

e. Touch test prod to test point and read proper scale on meter for value of AC Voltage

CAUTION

The case of the Voltmeter and the body of the AC probe are connected to the common test lead. Never connect the common test lead to the high potential portion of any circuit.

2-11. MAKING RESISTANCE MEASUREMENTS

2-12. GENERAL. Resistance measurements are made by using the common test lead (black with alligator clip) and the ohms test lead (red and red probe) (see figure 2-2, detail D).

a. Set the Function switch to the ohms position. Set the Range switch for the proper meter multiplier.

b. Connect the ohms test lead to the common lead and turn the DC ZERO ADJ knob until the meter pointer reads zero ohms.

c. Disconnect the test leads and turn the OHMS ADJ knob until the meter pointer reads infinity.

NOTE

If the approximate value of the resistance to be measured is unknown, start with the highest meter multiplier position. With the test leads connected across the terminals of the unknown resistance, move the Range switch from position to position in descending order until a range is found that permits easy reading of the meter.

d. Connect the test leads across the terminals of the unknown resistance. Note the position of the meter pointer on the top (OHMS) scale. Multiply this reading by the multiplier indicated by the Range switch.

EXAMPLE: An unknown resistance value is placed in series with the ohms test lead and the common test lead. The Range switch is set to the range at which the indicated resistance can be easily read on the meter OHMS scale. The indicated reading is 56 and the Range selector is set at the X100 position. The resistance value is 56×100 , or 5600. If the Range switch was in the X1 position, the resistance value should be 56×1 , or 56 ohms.

CAUTION

De-energize circuit under test before measuring resistance.

2-13. TURNING OFF VOLTMETER

2-14. To turn off power to the multimeter, turn Function switch to OFF position. Pilot light should cease to glow.

NOTES

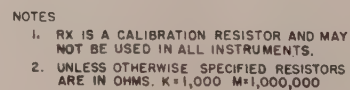


Figure 3-2. Schematic Wiring Diagram of Model 1600B

SECTION IV

TROUBLE SHOOTING

4-1. GENERAL INSTRUCTIONS

4-2. The Voltmeter is a complex electronic instrument. The manufacturer recommends, therefore, that within the limitations of this publication, trouble shooting and maintenance consist of the adjustments required to compensate for changes in circuit elements and replacement of tubes and obviously damaged components. If the equipment does not operate correctly after making adjustments or replacements, refer to the next higher level of maintenance.

4-3. TUBE FAILURE. The majority of troubles with in the Voltmeter will be caused by tube failure. Replacing the bad tube with a good one will frequently correct the trouble. It should be kept in mind, however, that tube failure may be caused by failure of a component in the same or in a related circuit. Often

faulty components may be found by visual inspection (discolored or burned resistors, leaking or burned capacitors).

4-4. Many tube testers cannot be depended upon to find all possible defects in a tube. A more reliable method is to substitute tubes known to be serviceable for suspected faulty ones. This may save considerable time in trouble localizing since a tube which tests satisfactorily in a tube tester may fail in a particular application.

4-5. Should the instrument fail in some respect, refer to the trouble shooting instructions in figure 4-1. Check out each of the probable causes and follow through with the servicing instructions given in the REMEDY column.

TROUBLE	PROBABLE CAUSE	REMEDY
METER DOES NOT REGISTER FOR ANY FUNCTION	Power supply off	Check power source and power cable. Move Function switch from OFF position.
	Power supply defective	Check tube V4 and transformer T1. Replace V4 if defective. Check heater supply by observing if filaments light. If heater supply or main winding on T1 is defective, refer to higher maintenance level.
	Damaged meter movement	Replace meter or refer to higher maintenance level.
METER READINGS INCORRECT FOR SOME OR ALL FUNCTIONS	Bridge circuit unbalanced	Refer to Section II
	Damaged meter movement	Refer to higher maintenance level.
	Voltage regulator defective	Check V5 and replace if defective.
	Burned out resistor in series string	Check and replace defective resistor.
	Diode rectifier V1 in AC probe burned out.	Replace diode per paragraph 3-6.
	Front panel controls improperly set, scale improperly read or test leads improperly connected	Review operation instructions

Figure 4-1. Table of Trouble Shooting Procedures

NOTES

SECTION V

CALIBRATION

5-1. CALIBRATION

5-2. GENERAL. Values of various circuit elements may change after continued use due to temperature changes, vibration and to aging of tubes, dielectrics, etc. The calibration procedures described in this section are provided so that the user can restore the instrument to its original accuracy.

5-3. This instrument utilizes two types of zero adjust controls for voltage readings; AC Adjust and DC Adjust. The DC Zero Adjust (black knob - figure 1-1) operates in a conventional manner, with the exception that instead of balancing the potential on the plates it balances the screen voltages on the two 6AU6 tubes. The AC Zero Adjust (red knob - figure 1-1) determines the amount of B+ necessary to cancel out the contact potential of tube V1.

5-4. During DC measurements only, the DC Zero Adjust is operative and it is used in the conventional manner. However, during AC measurements both the DC Zero Adjust and the AC Zero Adjust are operative.

5-5. An approved voltmeter calibrator or other voltage source of known accuracy (0.1%) should be used to supply calibrated DC and AC input voltages. The calibrator should be capable of furnishing DC voltages that are positive or negative to ground.

5-6. ZERO ADJUSTING METER

a. With the Function switch (figure 1-1) on AC Volts position, turn the Range switch to the 300V position and rotate the DC ZERO ADJ control until the meter indicates zero volts (black knob).

b. Turn the Range switch to the 1V position. Rotate the AC ZERO ADJ control (red knob) until a zero volt reading is indicated on the meter.

c. Repeat steps a and b, making minor adjustments in control settings if necessary.

5-7. CALIBRATING B+ SUPPLY WITH R37.

a. With 115 volts AC input to the instrument power supply, adjust potentiometer R37 (DC REG.) (see figure 1-5) for approximately 100 volts DC between the plate of voltage regulator tube V5A and ground.

b. Vary the AC supply voltage between 103 and 127 volts and check to see that the voltage on the plate (pin 5) of V5 remains constant. This establishes the + DC voltage regulation.

5-8. CALIBRATING OPERATING BIAS OF BRIDGE

a. Set Function switch to -DC position. Move Range switch through all voltage positions while observing meter pointer.

b. If meter pointer shifts from zero position as Range switch is rotated (momentary surges should be disregarded) turn potentiometer R27 BIAS (Rear Panel - figure 1-5) clockwise or counterclockwise un-

til meter pointer does NOT shift as Range switch is moved.

5-9. CALIBRATING DC RANGES. Calibration of the entire DC measuring circuit is accomplished by potentiometer R26 DC CAL (Rear Panel) using an approved voltmeter calibrator.

a. Turn the Function switch to +DC and the Range switch to 30V.

b. While applying 25 volts DC from the calibrator, adjust R26 for correct meter reading at 25 volts.

c. Check the 1V, 3V, 10V, 100V, 300V and 1000V ranges while applying voltages of 0.8, 2.5, 8.0, 80, 250 and 800 respectively. Readjust R26, if necessary, to obtain uniform accuracy on all ranges.

5-10. CALIBRATING THE AC VOLTAGE RANGES

The AC voltage ranges are calibrated by adjustment of potentiometers R4, R6, R9, R14, R43, and R44 (located on back panel) while applying the proper voltage from a voltmeter calibrator. The calibration procedure is accomplished in the following successive steps;

a. Turn the Function switch to the AC position and the range switch to the 1 volt position. Apply 0.8 VAC from the voltmeter calibrator and adjust R4 (1VAC) for proper meter reading.

b. Turn Range switch to 3 - apply 2.5 volts AC calibrate the 0 to 3 range of the meter by means of the R6 (3VAC).

c. Turn Range switch to 10 - apply 8.0 volts AC - calibrate the 0 to 10 range of the meter by means of the R9 (10 VAC).

d. Turn Range switch to 30 - apply 25 volts AC - calibrate the 0 to 30 range of the meter by means of the R14 (30 VAC).

e. Turn Range switch to 100 - apply 80 volts AC - calibrate the 0 to 100 range of the meter by means of the R43 (100 VAC).

f. Turn Range switch to 300 - apply 250 volts AC - calibrate the 0 to 300 range of the meter by means of the R44 (300 VAC).

5-11. CHECKING OHMMETER RANGES. The accuracy of the OHMS ranges can be checked using standard resistors of known accuracy. Resistance values should be selected to give readings approximately at mid-scale on the meter.

NOTES

SECTION VI

PARTS LIST

NOTICE

Manufacturers listed are "typical" sources of supply for the parts described.

The Hickok Electrical Instrument Company reserves the right to substitute equivalent products supplied by manufacturers not listed provided the part substituted is electrically and mechanically interchangeable with the part originally listed for use in the equipment.

REF. DESIG.	NOTES	NAME AND DESCRIPTION	HICKOK PART NO.
A1		PROBE ASSEMBLY, AC, consists of probe housing, cable, and the following electrical components: C1, L1, L2, R1, V1 and W1.	16970-60
A2		SWITCH ASSEMBLY, RANGE SELECTOR, consists of rotary switch S1 and the following electrical components: R3, R7, R8, R10, R11, R15, R16, R17, R18, R21, R22, R23, R24 and R28.	19915-648
C1		CAPACITOR, FIXED, CERAMIC: .01 uf, 500 Volts	3110-84
C2		CAPACITOR, FIXED, CERAMIC: .0027 uf.	3110-110
C3		CAPACITOR, FIXED, MICA: 2700 uuf, 10%, 500 Volts.	3095-41
C4		CAPACITOR, FIXED, ELECTROLYTIC: 20 uf, 450 Volts.	3085-5
C5		CAPACITOR, FIXED, ELECTROLYTIC: 100 uf, 6 Volts.	3085-64
C6		Same as C5	
C7		CAPACITOR, FIXED, MICA: 1000 uuf, 10%, 500 Volts.	3095-9
C8		Same as C7	
CR1		RECTIFIER: Silicon, 100 PIV, IN1692.	18150-57
DS1		LAMP: #51 pilot, 6-8 Volts.	12270-22
F1		FUSE: 3AG, 1/2 amp.	6900-44
J1		CONNECTOR: banana jack.	10300-54
J2		Same as J1	
J3		Same as J1	
J4		Same as J1	
J5		Same as J1	
L1		COIL: .68 uh	3320-132
L2		Same as L1	
M1		METER: Model 68, 100 Microamps.	680-237
MP1		KNOB ASSEMBLY: bar type with pointer.	11500-11
MP2		Same as MP1	
MP3		KNOB: red, small.	11505-85
MP4		KNOB: black, large	11505-91
MP5		KNOB: black, molded	11505-112
R1		RESISTOR, FIXED, COMPOSITION: 36 megohms, 5%, 1/3 Watt.	18525-840
R2		Same as R1	
R3		RESISTOR, FIXED, FILM: 12 ohms, 1%, 1 Watt.	18561-1
R4		POTENTIOMETER: 10K ohms, 10%, 2 Watt.	40400-103

REF. DESIG.	NOTES	NAME AND DESCRIPTION	HICKOK PART NO.
R5		POTENTIOMETER: dual 50K ohms, 10%, 2 watt each section	16925-427
R6		Same as R4	
R7		RESISTOR, FIXED, FILM: 57.33 megohms, 1%, 2 watt	18562-4
R8		RESISTOR, FIXED, FILM: 90 ohms, 1%, 1/2 watt	18560-1
R9		Same as R4	
R10		RESISTOR, FIXED, FILM: 20.07 megohms, 1%, 2 watt	18562-3
R11		RESISTOR, FIXED, FILM: 900 ohms, 1%, 1/2 watt	18560-3
R12		RESISTOR, FIXED, COMPOSITION: 390K ohms, 5%, 1/2 watt	18414-391
R13		Same as R12	
R14		Same as R4	
R15		RESISTOR, FIXED, FILM: 5.733 megohms, 1%, 1 watt	18561-5
R16		RESISTOR, FIXED, FILM: 9K ohms, 1%, 1/2 watt	18560-4
R17		RESISTOR, FIXED, FILM: 2.007 megohms, 1%, 1/2 watt	18560-18
R18		RESISTOR, FIXED, FILM: 90K ohms, 1%, 1/2 watt	18560-9
R19		RESISTOR, FIXED, COMPOSITION: 47K ohms, 5%, 1/2 watt	18413-471
R20		Same as R19	
R21		RESISTOR, FIXED, FILM: 573.3K ohms, 1%, 1/2 watt	18560-17
R22		RESISTOR, FIXED, FILM: 900K ohms, 1%, 1/2 watt	18560-12
R23		RESISTOR, FIXED, FILM: 200.7K ohms, 1%, 1/2 watt	18560-16
R24		RESISTOR, FIXED, FILM: 9 megohms, 1%, 1 watt	18561-4
R25		POTENTIOMETER: 10K ohms, 10%, 2 watt	40100-103
R26		Same as R4	
R27		POTENTIOMETER: 50K ohms, 10%, .2 watts	40400-503
R28		RESISTOR, FIXED, FILM: 86K ohms, 1%, 1/2 watt	18560-15
R29		Same as R5	
R30		RESISTOR, FIXED, COMPOSITION: 560K ohms, 10%, 1/2 watt	18414-562
R31		RESISTOR, FIXED, COMPOSITION: 33K ohms, 5%, 2 watts	18433-331
R32		RESISTOR, FIXED, COMPOSITION: 820K ohms, 5%, 1/2 watt	18414-821
R33		RESISTOR, FIXED, COMPOSITION: 47K ohms, 5%, 2 watts	18433-471
R34		RESISTOR, FIXED, COMPOSITION: 39K ohms, 5%, 1/2 watt	18413-391
R35		RESISTOR, FIXED, COMPOSITION: 75K ohms, 5%, 1/2 watt	18413-751

REF. DESIG.	NOTES	NAME AND DESCRIPTION	HICKOK PART NO.
R36		Same as R19	
R37		POTENTIOMETER: 100K ohms, 10%, .2 watt	40400-104
R38		RESISTOR, FIXED, COMPOSITION: 100 megohms, 10%, 2 watt	18575-215
R39		Same as R19	
R40		RESISTOR, FIXED, COMPOSITION: 180K ohms, 5%, 1/2 watt	18414-181
R41		RESISTOR, FIXED, FILM: 20 ohms, 1%, 1 watt	18561-2
R42		Same as R19	
R43		Same as R4	
R44		Same as R4	
RX		CALIBRATION RESISTOR: May not be used in all instruments	
RX1		RESISTOR, FIXED, COMPOSITION: 15 megohms, 10%, 1/2 watt	18416-152
RX2		RESISTOR, SPOOL: 750 ohms	18685-625
S1		SWITCH: rotary, 7 position, 4 sections, (Range Selector)	19912-555
S2		SWITCH: rotary, 5 positions, 4 sections (Function Selector)	19912-380
S3		SWITCH: slide, D. P. D. T., 125 volt, 1/2 amp.	19911-81
T1		TRANSFORMER: power, 115-230 volts, 50-1000 cps	20800-286
V1		ELECTRON TUBE: EA-52	20875-161
V2		ELECTRON TUBE: 6AU6	20875-215
V3		Same as V2	
V4		ELECTRON TUBE: 6X4	20875-68
V5		Same as V2	
V6		ELECTRON TUBE: Ballast Amperite 9-4	20875-223
VR1		LAMP: Neon, #NE-2, 65 ac volts, 90 volts, dc	12270-26
VR2		LAMP: Neon glow, NE-32	12270-21
W1		LEAD ASSEMBLY: RF ground, (Part of A1)	12450-323
W2		LEAD ASSEMBLY: ground	12450-381
W3		LEAD ASSEMBLY: Ohms	12450-382
W4		PROD: test, red, insulated, phono needle tip	16975-36
W5		PROD: test, black, insulated phono needle tip	16975-58
W6		CORD AND PLUG ASSEMBLY: 3 wire #18 AWG, 8 ft. long, 3 prong plug	3675-34

REF. DESIG.	NOTES	NAME AND DESCRIPTION	HICKOK PART NO.
W7		ADAPTER: Line Cord, 3 wire U ground female two parallel blades male.	1050-153
W8		LEAD ASSEMBLY: DC	3030-172
XDS1		SOCKET ASSEMBLY: panel light	19350-224
XF1		FUSEHOLDER: for F1	8825-14
XV2		SOCKET: 7 pin	19350-196
XV3		Same as XV2	
XV4		Same as XV2	
XV5		Same as XV2	
XV6		SOCKET: octal, crimp on, phenolic	19350-30
XVR2		SOCKET: Double contact, bayonet	19350-239
		BOOKLET: Instructions	2490-474

